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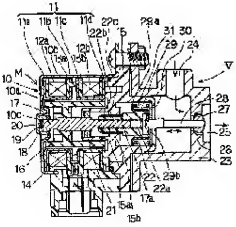
(54) **DRIVER EMPLOYING STEPPING MOTOR**

(57)Abstract:

PURPOSE: To bear a thrust load applied to the rotor output shaft not through a ball bearing but through an inexpensive simple bearing structure.

CONSTITUTION: A retainer 29 carried on a valve shaft 28 coupled with a valve 27 is subjected to the spring force of a coil spring 31 acting toward the side board 10a side (opposite to the valve side) of a motor case 10. A bearing structure comprising balls 18 and a metal plate 20 is disposed between one end part of a rotor output shaft 17 and the side board part 10a of the motor case 10 in order to bear the thrust load being



applied by the spring 31.

CLAIMS

[Claim(s)]

[Claim 1]A drive using a stepping motor which is provided with the following and characterized by allocating a bearing mechanism which receives thrust loading by spring action of said spring between an end part of said rotor output shaft, and said side plate part of said motor case.

A cylindrical motor case which has a disc-like side plate part.

An annular stator which is allocated in this motor case and generates a magnetic field.

A rotor which it is allocated in the inner circumference side of this annular stator via a small opening, enabling free rotation, and is rotated in response to said magnetic field.

A rotor output shaft in which that end counters said side plate part of said motor case while rotating to this rotor and one, A spring which energizes a driven subject which is combined with the other end side of this rotor output shaft via a mechanism which changes rotational movement into a straight-line motion, is combined with a driven shaft which carries out a straight-line motion, and this driven shaft, and operates by a straight-line motion of this driven shaft, and said driven subject to said side plate part side of said motor case.

[Claim 2]A drive using the stepping motor according to claim 1, wherein said bearing mechanism comprises metal plates with which a ball held pivotable between an end part of said rotor output shaft and said side plate part of said motor case and this ball contact.

[Claim 3]A drive using the stepping motor according to claim 1 or 2, wherein said bearing mechanism is stored in a

circular recess formed in the central part of said side plate part of said motor case.

[Claim 4]A drive using a stepping motor of any one statement of claim 1 thru/or 3, wherein it is a valve element which said driven subject is installed in a fluid channel, and controls a fluid flow rate, and said spring is constituted so that this valve element may be energized to a valve closing direction.

[Claim 5]A drive using a stepping motor of any one statement of claim 1 thru/or 4, wherein radial bearing which receives load to a radial direction of said rotor output shaft comprises cylindrical metal bearing.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application]This invention relates to the axial supporting structure of a drive which used the stepping motor, is used, for example for the valve element driving device of a flow control valve, and is preferred.

[0002]

[Description of the Prior Art]As a valve element driving device of a flow control valve, conventionally JP,4-27148,U, What was proposed in JP,4-108367,U, JP,5-106520,A, etc. is known, and he is trying for these drives to all control the opening of a valve element using a stepping motor.

[0003]If a device is described more concretely conventionally [above-mentioned], the driven shaft would be combined with the output shaft of the rotor of a stepping motor via the mechanism which changes rotational movement into a straight-line motion, and the valve element will be combined at the tip of this driven shaft. This valve element is arranged so that it may move to a valve closing direction to the valve seat of a fluid channel by advance of said driven shaft. Since the power of the spring which energizes a valve element to a valve closing direction acts on said driven shaft, the thrust by the side of a valve element, i.e., thrust loading, is always given to the rotor and output shaft of the stepping motor by said spring.

[0004]

[Problem(s) to be Solved by the Invention]As mentioned above, since thrust loading by the side of a valve element is added to the rotor and output shaft of a stepping motor with said spring, it is necessary to respond to this thrust loading with a device, conventionally, in the side edge

part of a rotor. Therefore, although the ball bearing was allocated in the side edge part of a rotor and the above-mentioned thrust loading was supported in this ball bearing, there was a problem that the cost of a bearing portion will become high by use of a ball bearing.

[0005]An object of this invention is to enable it to support thrust loading by a spring which was made in view of the point describing above, and is added to the rotor and output shaft of a stepping motor by the brief bearing structure which does not use a ball bearing.

[0006]

[Means for Solving the Problem]This invention adopts the following technical means in order to attain the above-mentioned purpose. In a drive which used a stepping motor in the invention according to claim 1, A cylindrical motor case (10) which has a disc-like side plate part (10a), An annular stator (14) which is allocated in this motor case (10) and generates a magnetic field, While rotating to a rotor (16) which it is allocated in the inner circumference side of this annular stator (14) via a small opening, enabling free rotation, and is rotated in response to said magnetic field, this rotor (16), and one, A rotor output shaft (17) in which the end counters said side plate part (10a) of said motor case (10), A driven shaft (28) which is combined with the other end side of this rotor output shaft (17) via a mechanism (17a, 22a) which changes rotational movement into a straight-line motion, and carries out a straight-line motion, A driven subject (27) which is combined with this driven shaft (28) and operates by a straight-line motion of this driven shaft (28), Have a spring (31) which energizes said driven subject (27) to said side plate part (10a) side of said motor case (10), and between an end part of said rotor output shaft (17), and said side plate part (10a) of said motor case (10), a bearing mechanism (19.) which receives thrust loading by spring action of said spring (31) It is characterized by

allocating 20).
[0007]In the invention according to claim 2, the stepping motor according to claim 1 in a used drive said bearing mechanism, It comprises metal plates (20) with which a ball (19) held pivotable between an end part of said rotor output shaft (17) and said side plate part (10a) of said motor case (10) and this ball contact.
[0008]In the invention according to claim 3, said bearing mechanism is stored in a drive which used the stepping motor according to claim 1 or 2 in a circular recess (10c) formed in the central part of said side plate part (10a) of said motor case (10). In the invention according to claim 4, in a drive using a stepping motor of any one statement of claim 1 thru/or 3, said driven subject, It is a valve element (27) which is installed in a fluid channel and controls a fluid flow rate, and said spring (31) is constituted so that this valve element (27) may be energized to a valve closing direction.
[0009]In a drive using a stepping motor of any one statement of claim 1 thru/or 4, radial bearing which receives load to a radial direction of said rotor output shaft (17) is constituted from the invention according to claim 5 by cylindrical metal bearing (18, 21). Numerals in a parenthesis of each above-mentioned means show a correspondence relation with a concrete means given in an example mentioned later.
[0010]
[Function and Effect of the Invention]According to the invention according to claim 1 to 5, since it has the above-mentioned technical means, the thrust to the direction of a side plate part of a motor case will act on a rotor output shaft according to the spring action of a coil spring, but. Since it can respond to thrust loading resulting from this spring thrust between the end part of a rotor output shaft, and the side plate part of a motor case, the bearing mechanism allocated in the end part of this

rotor output shaft can be made into the very brief bearing structure which does not use a ball bearing.
[0011]A bearing mechanism can be constituted from metal plates with which the ball held pivotable between the end part of the profit according to claim 2 and a rotor output shaft and the side plate part of a motor case and this ball specifically contact, and it can manufacture remarkably cheaply as compared with a ball bearing. Since the thrust block is constituted like the above between the end part of a rotor output shaft, and the side plate part of a motor case, Can make most sliding radii of this thrust block into zero, therefore the conventional rotor side edge part is supported in a ball bearing, As compared with the structure (a sliding radius serves as the same size as the outer diameter of a rotor) which responds to thrust loading, the sliding-friction loss in a thrust-loading bearing part can be reduced substantially.
[0012]
[Example]Hereafter, the example which shows this invention in a figure is described. In drawing 1 and 2, M shows a stepping motor and V shows the flow control valve by which a valve opening is controlled by this stepping motor M. By this example, the flow control valve V shows the example constituted as a control valve of the exhaust gas flow rate in the exhaust gas recirculation system of car motor.
[0013]In the stepping motor M, 10 is a cylindrical motor case and has the side plate part 10a and the cylindrical part 10b which were really formed from the iron system metal which is a magnetic body. 11 is a stator core and comprises 2 sets of stator cores 11a and 11b formed from the iron system metal which is a magnetic body, and 11c and 11d. The ctenidium-like magnetic pole tooth is formed in each inner periphery by turns these stator cores 11a and 11b and 11c and 11d. 12a and 12b are the exiting coils which generate a magnetic field, and are looped around the stator cores 11a and 11b and the inside (11c and 11d) via

the winding frames 13a and 13b made of resin. A n pole and the south pole are formed in the magnetic pole tooth of a stator cores [11a, 11b, 11c, and 11d] inner periphery by turns at a circumferencial direction of the magnetic field which the exiting coils 12a and 12b generate.

[0014]The above-mentioned stator core 11 and the exiting coils 12a and 12b constitute the annular stator 14 along the inner skin of the cylindrical part 10b of the motor case 10. By attaching to the open end side of the cylindrical part 10b of the motor case 10 the resin made cover 15 mentioned later, this stator 14 portion is pinched between this resin made cover 15 and the side plate part 10a of the motor case 10, and is being fixed in the motor case 10.

[0015]The rotor 16 is allocated in the inner circumference side of the above-mentioned annular stator 14 via the small opening, enabling free rotation. It comprises a plus TIKU magnet which this rotor 16 was approximately cylindrical, and mixed a ferrite and thermoplastics and was magnetized, and, as for this plus TIKU magnet, a n pole and the south pole are formed in the rotor circumferencial direction by turns. The interval of the n pole in this plus TIKU magnet and the south pole is set up identically to the interval of the n pole and the south pole of a said stator cores [11a, 11b, 11c, and 11d] magnetic pole tooth.

[0016]The inner periphery of this rotor 16 is combined with the metal rotor output shaft 17, and these both 16 and 17 rotate to one. The end part of the rotor output shaft 17 is allocated so that the side plate part 10a of the motor case 10 may be countered.

If it states more concretely, the circular recess 10c will be formed in the central part of the side plate part 10a, the end part of the rotor output shaft 17 would be inserted into this circular recess 10c, and the end part of the rotor output shaft 17 will have countered the bottom wall surface of the circular recess 10c.

[0017]The cylindrical metal bearing 18 is allocated between the end part peripheral face of the rotor output shaft 17, and the internal peripheral wall surface of the circular recess 10c, it responds to the load to the radial direction of the rotor output shaft 17 by this metal bearing 18, and the end part of the rotor output shaft 17 is supported, enabling free rotation. The hemispherical surface-like crevice is formed in the side of the end part of the rotor output shaft 17, and the ball 19 is held in this crevice, enabling free rotation. This ball 19 has contacted so that it may become the circular metal plates 20 allocated in the bottom wall surface of said circular recess 10c with rolling contact. These ball 19 and metal plates 20 are formed [both] from the iron system metal excellent in abrasion resistance, the ball 19 is formed with high-carbon-chromium bearing steel, and the metal plates 20 are specifically formed with tool steel.
[0018]The bearing mechanism which receives thrust loading by the side of the side plate part 10a added to the rotor output shaft 17 with these ball 19 and metal plates 20 is constituted, and this bearing mechanism is allocated in the inner circumference side of said metal bearing 18. The cylindrical metal bearing 21 is allocated between the shaft-orientations intermediate part of the rotor output shaft 17, and the cylindrical part 15a by which integral moulding was carried out to the resin made cover 15, and the intermediate part of the rotor output shaft 17 is supported by this metal bearing 21, enabling free rotation.
[0019]The external threaded section 17a is formed in the other end side of the rotor output shaft 17, and this external threaded section 17a has geared to the female screw part 22a of the column 22 fabricated approximately cylindrical (refer to drawing 2) by resin. The periphery side of the female screw part 22a of the column 22 forms in a cylinder peripheral face the tubed part 22c which has the

four shaft-orientations projected parts 22b in un-circular-shaped sectional shape and the example of drawing 2.
[0020]Corresponding to the tubed part 22c of this un-circular shape, the tubed part 15b by which integral moulding was carried out to the resin made cover 15 is formed in un-circular-shaped sectional shape (shape which has the shaft-orientations crevice 15c where said four shaft-orientations projected parts 22b fit into circular inner skin in this example).
While the tubed part 22c of the column 22 has movement of a hand of cut regulated by this tubed part 15b, it has fitted into shaft orientations slidably.
[0021]Since rotational movement of the column 22 is prevented by fitting of the tubed parts 15b and 22c of these two un-circular shape, the column 22 performs only the straight-line motion to shaft orientations by the screw-thread engagement structure of the rotor output shaft 17 and the column 22. Therefore, the mechanism which changes rotational movement of the rotor 16 into a straight-line motion by the above-mentioned screw-thread engagement structure will be constituted.
[0022]23 is metal valve housing, such as aluminum, and has the entrance 24 and the exit 25 of exhaust gas -- this exit 25 -- the valve seat 26 is immediately formed in the upper stream. The metal valve elements 27 are allocated in the downstream of an exhaust gas flow to this valve seat 26. This valve element 27 is really combined with the end part of the metal valve element axis 28, and the other end of this valve element axis 28 is really combined with the central part of the bottom wall surface 29b of the cup shape metal retainers 29. The valve element axis 28 is fitted loosely to the center hole 30a of the metal stopper plates 30 fixed to the resin made cover 15.
[0023]The coil spring 31 compresses between the flange 29a of said cup shape retainer 29, and the stopper plate 30, and they are ******** with a group. Therefore, the power of

this coil spring 31 will act as power of a valve closing direction (left of drawing 1) to the valve element axis 28. A paraphrase sets up the operation direction of the spring action of the coil spring 31 via the valve element 27, the valve element axis 28 and also the retainer 29, and the column 22 press the rotor output shaft 17 to the side plate part 10a side of the motor case 10.

[0024]Integral moulding of the projected piece 22d is carried out to the column 22 at the position of symmetry of the tip part.

In the hole 29c which was able to be made in the bottom wall surface 29b of the cup shape retainer 29, this projected piece 22d has penetrated this hole 29c as loose fitting is also.

As for the column 22, when the tip of the projected piece 29d contacts the stopper plate 30, the maximum advance position (open position of the valve element 27) is regulated.

[0025]Next, the operation of this example is explained in the above-mentioned composition. By controlling the energization to the exiting coils 12a and 12b, magnetization of the magnetic pole tooth of a stator cores [11a, 11b, 11c, and 11d] inner periphery is controlled, and the rotation and hand of cut of the rotor 16 and the rotor output shaft 17 are controlled. If this rotor output shaft 17 rotates, the column 22 will perform the straight-line motion to shaft orientations by engagement with the external threaded section 17a and the female screw part 22a.

[0026]When the column 22 moves forward rightward [drawing 1], the valve element 27 is displaced rightward [drawing 1] via the retainer 29 and the valve element axis 28, compressing the coil spring 31, and the valve element 27 is moved to a valve opening direction. On the other hand, when the column 22 retreats leftward [drawing 1], the valve element 27 is displaced leftward [drawing 1] via the retainer 29 and the valve element axis 28 according to the

spring action of the coil spring 31, and the valve element 27 is moved to a valve closing direction.

[0027]Since displacement of the column 22 is transmitted to the valve element axis 28 via the retainer 29 and the spring 31 movable to shaft orientations to the column 22, without being directly transmitted to the valve element axis 28 also when the valve element 27 contacts the valve seat 26 (seating), the valve element 27 does not contact shockingly. That is, the bumper style which prevents the valve element 27 from sitting down shockingly to the valve seat 31 with the column 22, the retainer 29, the spring 31, and the stopper plate 30 is constituted.

[0028]As mentioned above, by controlling the rotation and hand of cut of the rotor output shaft 17, opening and closing of the valve element 27 are controlled, and the amount of exhaust gas recirculation to an automobile engine is adjusted. By the way, although the thrust to the direction of side plate part 10a of the motor case 10 will act on the rotor output shaft 17 according to the spring action of the coil spring 31, it can respond to thrust loading resulting from this spring thrust with the ball 19 and the metal plates 20.

[0029]Since the ball 19 was allocated in the central part of the end part of the rotor output shaft 17 and it is in contact with the metal plates 20 in rolling contact at this time, most of that sliding radius is zero. Therefore, as compared with the structure (a sliding radius serves as the same size as the outer diameter of a rotor) which responds to thrust loading in support of the conventional rotor side edge part in a ball bearing, the sliding-friction loss in a thrust-loading bearing part can be reduced substantially.

[0030]Although the two metal bearing 18 and 21 is allocated as radial bearing of the rotor output shaft 17 in the above-mentioned example, Since the role of the metal bearing 21 can be played in this fitting structure if the dimensional accuracy of the fitting part of the tubed parts

15b and 22c of the column 22 and the housing 15 is raised and the fitting crevice between both these tubed parts 15b and 22c is set as a sufficiently small value, it is also possible to abolish the metal bearing 21.

[0031]As for this invention, although the above-mentioned example described the case where the opening-and-closing drive of the valve element 27 of the flow control valve V was carried out with the stepping motor M, it is needless to say that it is applicable also to the drive of other uses other than a valve element drive.

TECHNICAL FIELD

[Industrial Application]This invention relates to the axial supporting structure of a drive which used the stepping motor, is used, for example for the valve element driving device of a flow control valve, and is preferred.

PRIOR ART

[Description of the Prior Art]As a valve element driving device of a flow control valve, conventionally JP,4-27148,U, What was proposed in JP,4-108367,U, JP,5-106520,A, etc. is known, and he is trying for these drives to all control the opening of a valve element using a stepping motor.

[0003]If a device is described more concretely conventionally [above-mentioned], the driven shaft would be combined with the output shaft of the rotor of a stepping motor via the mechanism which changes rotational movement into a straight-line motion, and the valve element will be combined at the tip of this driven shaft. This valve element is arranged so that it may move to a valve closing direction to the valve seat of a fluid channel by advance of said driven shaft. Since the power of the spring which energizes a valve element to a valve closing direction acts on said driven shaft, the thrust by the side of a valve element, i.e., thrust loading, is always given to the rotor and output shaft of the stepping motor by said spring.

EFFECT OF THE INVENTION

[Function and Effect of the Invention]According to the invention according to claim 1 to 5, since it has the above-mentioned technical means, the thrust to the direction of a side plate part of a motor case will act on a rotor output shaft according to the spring action of a coil spring, but. Since it can respond to thrust loading resulting from this spring thrust between the end part of a rotor output shaft, and the side plate part of a motor case, the bearing mechanism allocated in the end part of this rotor output shaft can be made into the very brief bearing structure which does not use a ball bearing.

[0011]A bearing mechanism can be constituted from metal plates with which the ball held pivotable between the end part of the profit according to claim 2 and a rotor output shaft and the side plate part of a motor case and this ball specifically contact, and it can manufacture remarkably cheaply as compared with a ball bearing. Since the thrust block is constituted like the above between the end part of a rotor output shaft, and the side plate part of a motor case, Can make most sliding radii of this thrust block into zero, therefore the conventional rotor side edge part is supported in a ball bearing, As compared with the structure (a sliding radius serves as the same size as the outer diameter of a rotor) which responds to thrust loading, the sliding-friction loss in a thrust-loading bearing part can be reduced substantially.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]As mentioned above, since thrust loading by the side of a valve element is added to the rotor and output shaft of a stepping motor with said spring, it is necessary to respond to this thrust loading with a device, conventionally, in the side edge part of a rotor. Therefore, although the ball bearing was allocated in the side edge part of a rotor and the above-mentioned thrust loading was supported in this ball bearing, there was a problem that the cost of a bearing portion will become high by use of a ball bearing.

[0005]An object of this invention is to enable it to support thrust loading by a spring which was made in view of the point describing above, and is added to the rotor and output shaft of a stepping motor by the brief bearing structure which does not use a ball bearing.

MEANS

[Means for Solving the Problem]This invention adopts the following technical means in order to attain the above-mentioned purpose. In a drive which used a stepping motor in the invention according to claim 1, A cylindrical motor case (10) which has a disc-like side plate part (10a), An annular stator (14) which is allocated in this motor case (10) and generates a magnetic field, While rotating to a rotor (16) which it is allocated in the inner circumference side of this annular stator (14) via a small opening, enabling free rotation, and is rotated in response to said magnetic field, this rotor (16), and one, A rotor output shaft (17) in which the end counters said side plate part (10a) of said motor case (10), A driven shaft (28) which is combined with the other end side of this rotor output shaft (17) via a mechanism (17a, 22a) which changes rotational movement into a straight-line motion, and carries out a straight-line motion, A driven subject (27) which is combined with this driven shaft (28) and operates by a straight-line motion of this driven shaft (28), Have a spring (31) which energizes said driven subject (27) to said side plate part (10a) side of said motor case (10), and between an end part of said rotor output shaft (17), and said side plate part (10a) of said motor case (10), a bearing mechanism (19.) which receives thrust loading by spring action of said spring (31) It is characterized by allocating 20).

[0007]In the invention according to claim 2, the stepping motor according to claim 1 in a used drive said bearing mechanism, It comprises metal plates (20) with which a ball (19) held pivotable between an end part of said rotor output shaft (17) and said side plate part (10a) of said motor case (10) and this ball contact.

[0008]In the invention according to claim 3, said bearing

mechanism is stored in a drive which used the stepping motor according to claim 1 or 2 in a circular recess (10c) formed in the central part of said side plate part (10a) of said motor case (10). In the invention according to claim 4, in a drive using a stepping motor of any one statement of claim 1 thru/or 3, said driven subject, It is a valve element (27) which is installed in a fluid channel and controls a fluid flow rate, and said spring (31) is constituted so that this valve element (27) may be energized to a valve closing direction.

[0009]In a drive using a stepping motor of any one statement of claim 1 thru/or 4, radial bearing which receives load to a radial direction of said rotor output shaft (17) is constituted from the invention according to claim 5 by cylindrical metal bearing (18, 21). Numerals in a parenthesis of each above-mentioned means show a correspondence relation with a concrete means given in an example mentioned later.

EXAMPLE

[Example]Hereafter, the example which shows this invention in a figure is described. In drawing 1 and 2, M shows a stepping motor and V shows the flow control valve by which a valve opening is controlled by this stepping motor M. By this example, the flow control valve V shows the example constituted as a control valve of the exhaust gas flow rate in the exhaust gas recirculation system of car motor.

[0013]In the stepping motor M, 10 is a cylindrical motor case and has the side plate part 10a and the cylindrical part 10b which were really formed from the iron system metal which is a magnetic body. 11 is a stator core and comprises 2 sets of stator cores 11a and 11b formed from the iron system metal which is a magnetic body, and 11c and 11d. The ctenidium-like magnetic pole tooth is formed in each inner periphery by turns these stator cores 11a and 11b and 11c and 11d. 12a and 12b are the exiting coils which generate a magnetic field, and are looped around the stator cores 11a and 11b and the inside (11c and 11d) via the winding frames 13a and 13b made of resin. A n pole and the south pole are formed in the magnetic pole tooth of a stator cores [11a, 11b, 11c, and 11d] inner periphery by turns at a circumferencial direction of the magnetic field which the exiting coils 12a and 12b generate.

[0014]The above-mentioned stator core 11 and the exiting coils 12a and 12b constitute the annular stator 14 along the inner skin of the cylindrical part 10b of the motor case 10. By attaching to the open end side of the cylindrical part 10b of the motor case 10 the resin made cover 15 mentioned later, this stator 14 portion is pinched between this resin made cover 15 and the side plate part 10a of the motor case 10, and is being fixed in the motor case 10.

[0015]The rotor 16 is allocated in the inner circumference

side of the above-mentioned annular stator 14 via the small opening, enabling free rotation. It comprises a plus TIKU magnet which this rotor 16 was approximately cylindrical, and mixed a ferrite and thermoplastics and was magnetized, and, as for this plus TIKU magnet, a n pole and the south pole are formed in the rotor circumferencial direction by turns. The interval of the n pole in this plus TIKU magnet and the south pole is set up identically to the interval of the n pole and the south pole of a said stator cores [11a, 11b, 11c, and 11d] magnetic pole tooth.

[0016]The inner periphery of this rotor 16 is combined with the metal rotor output shaft 17, and these both 16 and 17 rotate to one. The end part of the rotor output shaft 17 is allocated so that the side plate part 10a of the motor case 10 may be countered.

If it states more concretely, the circular recess 10c will be formed in the central part of the side plate part 10a, the end part of the rotor output shaft 17 would be inserted into this circular recess 10c, and the end part of the rotor output shaft 17 will have countered the bottom wall surface of the circular recess 10c.

[0017]The cylindrical metal bearing 18 is allocated between the end part peripheral face of the rotor output shaft 17, and the internal peripheral wall surface of the circular recess 10c, it responds to the load to the radial direction of the rotor output shaft 17 by this metal bearing 18, and the end part of the rotor output shaft 17 is supported, enabling free rotation. The hemispherical surface-like crevice is formed in the side of the end part of the rotor output shaft 17, and the ball 19 is held in this crevice, enabling free rotation. This ball 19 has contacted so that it may become the circular metal plates 20 allocated in the bottom wall surface of said circular recess 10c with rolling contact. These ball 19 and metal plates 20 are formed [both] from the iron system metal excellent in abrasion resistance, the ball 19 is formed with high-

carbon-chromium bearing steel, and the metal plates 20 are specifically formed with tool steel.

[0018]The bearing mechanism which receives thrust loading by the side of the side plate part 10a added to the rotor output shaft 17 with these ball 19 and metal plates 20 is constituted, and this bearing mechanism is allocated in the inner circumference side of said metal bearing 18. The cylindrical metal bearing 21 is allocated between the shaft-orientations intermediate part of the rotor output shaft 17, and the cylindrical part 15a by which integral moulding was carried out to the resin made cover 15, and the intermediate part of the rotor output shaft 17 is supported by this metal bearing 21, enabling free rotation.

[0019]The external threaded section 17a is formed in the other end side of the rotor output shaft 17, and this external threaded section 17a has geared to the female screw part 22a of the column 22 fabricated approximately cylindrical (refer to drawing 2) by resin. The periphery side of the female screw part 22a of the column 22 forms in a cylinder peripheral face the tubed part 22c which has the four shaft-orientations projected parts 22b in un-circular-shaped sectional shape and the example of drawing 2.

[0020]Corresponding to the tubed part 22c of this un-circular shape, the tubed part 15b by which integral moulding was carried out to the resin made cover 15 is formed in un-circular-shaped sectional shape (shape which has the shaft-orientations crevice 15c where said four shaft-orientations projected parts 22b fit into circular inner skin in this example).

While the tubed part 22c of the column 22 has movement of a hand of cut regulated by this tubed part 15b, it has fitted into shaft orientations slidably.

[0021]Since rotational movement of the column 22 is prevented by fitting of the tubed parts 15b and 22c of these two un-circular shape, the column 22 performs only the straight-line motion to shaft orientations by the

screw-thread engagement structure of the rotor output shaft 17 and the column 22. Therefore, the mechanism which changes rotational movement of the rotor 16 into a straight-line motion by the above-mentioned screw-thread engagement structure will be constituted.

[0022]23 is metal valve housing, such as aluminum, and has the entrance 24 and the exit 25 of exhaust gas -- this exit 25 -- the valve seat 26 is immediately formed in the upper stream. The metal valve elements 27 are allocated in the downstream of an exhaust gas flow to this valve seat 26. This valve element 27 is really combined with the end part of the metal valve element axis 28, and the other end of this valve element axis 28 is really combined with the central part of the bottom wall surface 29b of the cup shape metal retainers 29. The valve element axis 28 is fitted loosely to the center hole 30a of the metal stopper plates 30 fixed to the resin made cover 15.

[0023]The coil spring 31 compresses between the flange 29a of said cup shape retainer 29, and the stopper plate 30, and they are ******** with a group. Therefore, the power of this coil spring 31 will act as power of a valve closing direction (left of drawing 1) to the valve element axis 28. A paraphrase sets up the operation direction of the spring action of the coil spring 31 via the valve element 27, the valve element axis 28 and also the retainer 29, and the column 22 press the rotor output shaft 17 to the side plate part 10a side of the motor case 10.

[0024]Integral moulding of the projected piece 22d is carried out to the column 22 at the position of symmetry of the tip part.

In the hole 29c which was able to be made in the bottom wall surface 29b of the cup shape retainer 29, this projected piece 22d has penetrated this hole 29c as loose fitting is also.

As for the column 22, when the tip of the projected piece 29d contacts the stopper plate 30, the maximum advance

position (open position of the valve element 27) is regulated.

[0025]Next, the operation of this example is explained in the above-mentioned composition. By controlling the energization to the exiting coils 12a and 12b, magnetization of the magnetic pole tooth of a stator cores [11a, 11b, 11c, and 11d] inner periphery is controlled, and the rotation and hand of cut of the rotor 16 and the rotor output shaft 17 are controlled. If this rotor output shaft 17 rotates, the column 22 will perform the straight-line motion to shaft orientations by engagement with the external threaded section 17a and the female screw part 22a.

[0026]When the column 22 moves forward rightward [drawing 1], the valve element 27 is displaced rightward [drawing 1] via the retainer 29 and the valve element axis 28, compressing the coil spring 31, and the valve element 27 is moved to a valve opening direction. On the other hand, when the column 22 retreats leftward [drawing 1], the valve element 27 is displaced leftward [drawing 1] via the retainer 29 and the valve element axis 28 according to the spring action of the coil spring 31, and the valve element 27 is moved to a valve closing direction.

[0027]Since displacement of the column 22 is transmitted to the valve element axis 28 via the retainer 29 and the spring 31 movable to shaft orientations to the column 22, without being directly transmitted to the valve element axis 28 also when the valve element 27 contacts the valve seat 26 (seating), the valve element 27 does not contact shockingly. That is, the bumper style which prevents the valve element 27 from sitting down shockingly to the valve seat 31 with the column 22, the retainer 29, the spring 31, and the stopper plate 30 is constituted.

[0028]As mentioned above, by controlling the rotation and hand of cut of the rotor output shaft 17, opening and closing of the valve element 27 are controlled, and the amount of exhaust gas recirculation to an automobile engine

is adjusted. By the way, although the thrust to the direction of side plate part 10a of the motor case 10 will act on the rotor output shaft 17 according to the spring action of the coil spring 31, it can respond to thrust loading resulting from this spring thrust with the ball 19 and the metal plates 20.

[0029]Since the ball 19 was allocated in the central part of the end part of the rotor output shaft 17 and it is in contact with the metal plates 20 in rolling contact at this time, most of that sliding radius is zero. Therefore, as compared with the structure (a sliding radius serves as the same size as the outer diameter of a rotor) which responds to thrust loading in support of the conventional rotor side edge part in a ball bearing, the sliding-friction loss in a thrust-loading bearing part can be reduced substantially.

[0030]Although the two metal bearing 18 and 21 is allocated as radial bearing of the rotor output shaft 17 in the above-mentioned example, Since the role of the metal bearing 21 can be played in this fitting structure if the dimensional accuracy of the fitting part of the tubed parts 15b and 22c of the column 22 and the housing 15 is raised and the fitting crevice between both these tubed parts 15b and 22c is set as a sufficiently small value, it is also possible to abolish the metal bearing 21.

[0031]As for this invention, although the above-mentioned example described the case where the opening-and-closing drive of the valve element 27 of the flow control valve V was carried out with the stepping motor M, it is needless to say that it is applicable also to the drive of other uses other than a valve element drive.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a sectional view showing one example of this invention.

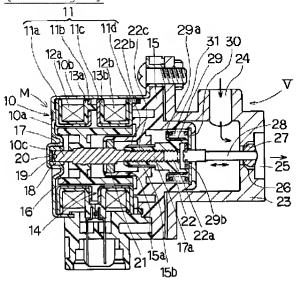
[Drawing 2]They are some exploded perspective views of drawing 1.

[Description of Notations]

10 [.... Circular recess,] .... A motor case, 10a .... A side plate part, 10b .... A cylindrical part, 10c 14 [.... A rotor output shaft, 18, 21 / .... Metal bearing, 19 / .... A ball, 20 / .... Metal plates, 27 / .... A valve element (driven subject) 28 / .... A valve element axis (driven shaft) 31 / .... Spring.] .... A stator, 15 .... Covering, 16 .... A rotor, 17

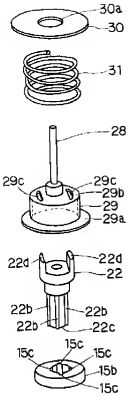
DRAWINGS

[Drawing 1]



10: モータケース
10a: 側板部
10b: 円筒状部
10c: 円形凹部
11: ステータコア
12a, 12b: 励磁コイル
14: ステータ
15: カバー
16: ロータ
17: ロータ出力軸
18, 21: メタル軸受
19: ボール
20: 金属製平板
27: 弁体（被駆動対象物）
28: 弁体軸（被駆動軸）
31: スプリング

[Drawing 2]


30a
30
31
28
29c
29c
29b
29
29a
22d
22d
22
22b
22b
22b
22c
15c
15c
15c
15b
15c